

## REMARKS

Claims 1, 2 and 9-11, 14, 15, 18 and 19 remain pending for further prosecution in the present application. Applicant submits arguments for overcoming the rejections over the prior art of record and respectfully requests reconsideration. Accordingly, Applicant respectfully submits that the present application is in condition for allowance.

### **I. Claim Rejections - 35 USC §103(a)**

- A. *In the FINAL Office Action dated August 19, 2010, claims 1, 2, 9-11, 14, 15, 18 and 19 are rejected under 35 USC §103(a) as being obvious over U.S. Patent Application Publication No. 2003/0062261 A1 of Shindo.*

Independent claims 1, 2 and 11 of the present application require a hafnium material, a sputtering target, and a thin film deposited on a substrate that consists of hafnium of at least 4N (99.99wt%) purity (with Zr and gas components being excluded from the purity determination), Zr content of 0.1wt% (1000wtppm) or less and oxygen content (as a gas component) of 40wtppm or less. In addition, sulfur and phosphorus contents are each 10wtppm or less.

In the FINAL Office Action, the claims are rejected on the basis that:

“... the composition disclosed by Shindo (‘261) overlaps the composition of the instance invention, which is *prima facie* evidence of obviousness. MPEP2144.05 I.”

Applicant believes this to be an error and respectfully disagrees that the composition disclosed by Shindo (‘261) overlaps the composition as required by the claims of the present application. Accordingly, Applicant respectfully submits that a *prima facie* case of obviousness cannot be established with Shindo (‘261).

Further, Applicant respectfully submits that the teachings of Shindo (‘261) actually teach away from the Zr content required by the claims of the present application and that the oxygen

content required by the claims of the present application is critical for achieving a result unexpected by one of ordinary skill in the art following the teachings of Shindo ('261).

Shindo ('261) discloses a hafnium material having oxygen content of 500ppm or less and zirconium content of 0.5wt% (5000ppm) or less in a fully-refined hafnium material. Accordingly, one of ordinary skill in the art at the time of the effective filing date of the present application is able to acknowledge that the upper limits of O and Zr taught by Shindo ('261) for a fully-refined hafnium material are 500ppm and 0.5wt% (5000ppm), respectively. However, one of ordinary skill in the art at the time of the effective filing date of the present application was not made aware of the lower limits of O and Zr contents. This has been previously admitted by the Examiner; for example, see the Office Action dated April 12, 2010 on page 10, lines 10-12, as follows:

“... Shindo ('261) discloses upper limits for components such as oxygen and zirconium and a minimum content of specific elements cannot necessarily be associated therewith.”

One of ordinary skill in the art relying on common sense would clearly understand that a lower limit of content of O and Zr in a hafnium material will always exist and that it will be based on the refining method used. This is particularly true for O and Zr contents in a hafnium material because O and Zr exist in large quantities in hafnium materials and separation of O and Zr from hafnium materials is extremely difficult.

To determine an actual lower limit, one of ordinary skill in the art relying on common sense would look to the examples provided in the publication. Here, Shindo ('261) teaches that the amount of zirconium in a fully-refined hafnium material is 3500ppm (0.35%) or 2400ppm (0.24%) and the amount of oxygen (as a gas component) in a fully-refined hafnium material is 120ppm. These analytical values are clearly understood to be lower than the above stated upper

limits of 5000ppm (0.5%) Zr and 500ppm O as taught by Shindo ('261). Thus, the 3500ppm or 2400ppm Zr and 120ppm O comply with and enable the "or less" requirement of Shindo ('261).

Applicant respectfully submits that when the lower limits of O and Zr content are clearly undefined, as previously admitted by the Examiner, it is an error to conclude that the unknown lower limits of Shindo ('261) necessarily "overlap" with the requirements of 40ppm or less O content and 1000ppm (0.1wt%) Zr content required by the claims of the present application. It is reasonable based on the disclosure of Shindo ('261) that the lower limits are 3500ppm or 2400ppm Zr and 120ppm O as defined by the examples. Thus, there would be no overlap.

Accordingly, Applicant respectfully submits that, based on a fair reading of Shindo ('261), the "lower limit" would in fact be that disclosed in the examples. If lower limits were possible or desirable, such lower limits would have been disclosed. Thus, Applicant respectfully submits that one of ordinary skill in the art at the time of the effective filing date of the present application would logically consider 3500ppm or 2400ppm Zr and 120ppm O to be the lower limits. Again, the result is that there is no overlap.

Accordingly, Applicant respectfully submits that there is no "overlap" and that a *prima facie* case of obviousness cannot be properly established on this basis. Applicant respectfully requests reconsideration and removal of the rejection for at least this reason.

As an additional reason for non-obviousness, Applicant respectfully submits that Shindo ('261) teach away from lowering Zr content beyond 3500 or 2400ppm and provides no motivation for the further lowering of Zr content in a hafnium material.

For example, Shindo ('261) teaches to one of ordinary skill in the art that a large quantity of zirconium is contained in hafnium, that the separation and refinement between the two is difficult, and that the presence of zirconium "may be *disregarded* since the purpose of use of the

respective materials *will not hinder* overall purpose hereof.” (See Paragraph No. 0061 of the ‘261 Shindo published application.) Also, Paragraph No. 0065 of Shindo (‘261) teaches to one of ordinary skill in the art that it is “*extremely difficult to reduce Zr* in high purity hafnium” and “the fact that Zr is mixed in high-purity hafnium *will not aggravate* the properties of semiconductors, and *will not be a problem.*” Thus, Shindo (‘261) provides a clear teaching that the inclusion of zirconium in a hafnium material in itself is not problematic since a zirconium content of 5000ppm, 3500ppm and 2400ppm will not deteriorate the characteristics of semiconductors. Accordingly, based on this teaching, one of ordinary skill in the art as of the effective filing date of the present application would be provide with no common sense motivation to even attempt further refinement of the hafnium material with respect to the above stated content of zirconium thereby teaching away from the present invention. Thus, it would not be obvious for one of ordinary skill in the art to reduce Zr content to that required by the claims of the present application.

Still further, the reduction of O content to the levels required by the claims of the present application is critical and provides an unexpected result relative to the teachings of Shindo (‘261).

Shindo (‘261) discloses reducing oxygen content from 500ppm to 120ppm based on “electron beam melting” refining techniques. This clearly does not reach the level of 40wtppm or less or 10wtppm as claimed in the present application and “electron beam melting” cannot be used to reach this level. In contrast, the present invention reduces oxygen by performing “molten salt electrolysis” and only thereby achieves an oxygen content of 40ppm or less. More specifically, the molten salt of Ca and  $\text{CaCl}_2$  is used and hafnium is reduced (deoxygenized) based on electrolysis (not electron beam melting as taught by Shindo (‘261)).

Tables 1-4 on pages 7-9 of the present application, as filed, disclose oxygen content and residual resistance ratio of three examples of a refined hafnium material according to the present invention before and after being subject to above referenced “deoxidation”. The ingots before “deoxidation” have oxygen contents of 250, 400 and 100ppm and low residual resistance ratios of 38, 22 and 45. However, after the deoxidation process disclosed by the present application, the further-refined ingots have oxygen contents of 20ppm and less than 10ppm and high residual resistance ratios of 200, 120 and 190. Thus, the 40ppm or less oxygen content of the present invention provides a critical result of increasing the residual resistance ratio of the hafnium material which is completely unexpected from the teachings of Shindo (‘261).

For all the above reasons, Applicant respectfully submits that the claims of the present application are patentable and are non-obvious relative to the teachings of Shindo (‘261). Accordingly, Applicant respectfully requests reconsideration and removal of the rejection.

B. *In the FINAL Office Action of August 19, 2010, claims 1, 2, 9, 10, 18 and 19 are rejected under 35 USC §103(a) as being obvious over ASM Handbook Volume 2, pp. 1093-1097.*

Applicant respectfully requests reconsideration of the above referenced rejection because it is respectfully submitted that the Examiner is incorrectly interpreting the reference.

The referenced ASM Handbook relates to chemical vapor deposition and discloses that refining is possible with an iodide pyrolysis method. The ASM Handbook, page 1094, provides the following disclosure:

“One of the more popular of the chemical vapor deposition processes is the iodide process, which has been used extensively to purify titanium, zirconium, and chromium (Ref 5). For each of these metals, the starting charge of metal is reacted to form a volatile metal iodide compound, which in turn is thermally decomposed to liberate iodine vapor. The pure metal is allowed to condense onto a suitable heated substrate (glass tubes and wires of the base metal have been used), while the iodine returns to the metal charge to form more iodide compound. Hence, the iodine acts as a carrier of the metal from the charge to the substrate.

In this process, some impurities are always carried over to the vapor phase along with the metal being purified. ... In all cases, the starting metal has a purity of about 99.9%. Chromium has been purified to its highest state to date by this method. Only iron is carried over with these metals to a significant extent. Thus, if a low-iron starting metal is used, the condensed vapor will approach a purity level of 99.999%.

*Other metals* that have been purified by chemical vapor deposition include *hafnium*, thorium, vanadium, niobium, tantalum, molybdenum, and many less commercially important metals (Ref 5).”

According to the beginning of the above recited first paragraph, Ti, Zr and Cr are metals of which the iodide process is most broadly applied. In the description “...which has been used extensively to purify titanium, zirconium, and chromium (Ref 5)” and “For each of these metals, the starting charge ...”, it is clear that the intention of the author is that the phrase “these metals” specifically refers to titanium, zirconium, and chromium which are the only metals having been disclosed by the author to this point of the article.

The second paragraph recited above discloses typical purity level examples for Ti, Zr and Cr (i.e. “**these metals**”) that are purified with the iodide process. This paragraph of the ASM Handbook discloses that: “In all cases, the starting metal has a purity of about 99.9%.” These “cases” specifically refer to the cases of Ti, Zr and Cr.

The last two sentences of the second paragraph recited above provide the following description: “Only iron is carried over with **these metals** to a significant extent. Thus, if a low-iron starting metal is used, the condensed vapor will approach a purity level of 99.999%.” Again, the author consistently refers to “**these metals**”, and “**these metals**” clearly refer to Ti, Zr and Cr which are the only metals disclosed to this point of the article. A high-purity hafnium material has not yet been disclosed in the article to this point. Thus, reference to “**these metals**” certainly cannot include a high purity hafnium material since a high-purity hafnium material has not yet been referenced by the article.

After the description provided in the second paragraph with respect to “these metals” and a purity level approaching 5N, the ASM Handbook provides the following description: “***Other metals*** that have been purified by chemical vapor deposition include *hafnium*, thorium, vanadium, niobium, tantalum, molybdenum, and many less commercially important metals (Ref 5).” Note that a reference to purifying hafnium is included in the recitation of “***other metals***” and not in connection with the recitation of “**these metals**”.

Accordingly, one of ordinary skill in the art learns from the ASM Handbook that a CVD method can be applied to “other metals” such as hafnium; however, the ASM Handbook completely fails to teach, in any way, the purity level of Hf that can be achieved with the CVD method or the applicability of the iodide process to Hf.

Further, the ASM Handbook specifically references a “Ref. 5” in the above paragraphs. From an inspection of “Ref. 5” (of record in the present application), the purity of Hf subject to the iodide process is 98.92 to 99.22% and the oxygen content is 140 to 500ppm. These values are significantly different from that required by the claims of the present application and clearly do not “overlap” the requirements of the claims of the present application. Accordingly, Applicant respectfully submits that a *prima facie* case of obviousness has not been established.

Still further, there is absolutely no scientific support for the conclusion that if a person skilled in the art applied the CVD method of the ASM Handbook to low iron-containing hafnium with a purity of 99.9% that Hf with a purity of 99.999% would be obtainable. The statement in the ASM Handbook with respect to approaching 99.999% purity is with respect to “these metals” not the “*other metals*”. At the point in the ASM Handbook article in which “low Fe-containing” and “approaching 99.999% purity” is discussed, the “*other metals*” including hafnium have not yet been referenced by the author. Thus, the “approaching 99.999% purity” statement of the ASM Handbook is specific with respect to Ti, Zr and Cr (i.e. “these metals”).

Accordingly, for all the above reasons, Applicant respectfully submits that the ASM Handbook has been misinterpreted, that it fails to disclose a hafnium material “overlapping” with the requirements of the claims of the present application, and that a *prima facie* case of obviousness cannot be provided by the ASM Handbook. Applicant respectfully requests reconsideration and removal of the rejection.



## **II. Conclusion**

In view of the above remarks, Applicant respectfully submits that the claim rejections have been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

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Respectfully submitted,  
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